

# PATENT SPECIFICATION

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NO DRAWINGS

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## COMPLETE SPECIFICATION.

### Foamable Polystyrene and Process for Moulding It.

We, MONSANTO CHEMICALS LIMITED, a British company of Monsanto House, 10-18 Victoria Street, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to foamable resins, and particularly to foamable polystyrene and a process for moulding it.

Foamed polystyrene is an important industrial commodity, particularly in the form of blocks which are cut up into boards and other shapes. Blocks are commonly produced by a process in which foamable particles consisting essentially of polystyrene and a volatile hydrocarbon blowing agent are expanded by the action of heat so as to produce a "prefoam" of foamed beads, and these foamed beads are placed in a suitable mould and heated by steam in a moulding operation where expansion and consolidation of the beads takes place and a block conforming to the shape of the mould is produced. This process works well in principle, but is capable of improvement in certain respects; in particular for instance it would be advantageous to shorten the time for which a block sometimes needs to be allowed to cool before it can be safely removed from the mould. However, it has now been found that an improvement can be effected in this respect if a specially treated foamable polystyrene is employed. A further advantage that results is that the moisture content of the block is lowered.

The invention comprises foamable polystyrene particles that consist essentially of polystyrene, a volatile hydrocarbon blowing agent, and from 0.1 to 10% of a wax by weight of the polystyrene.

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The process of the invention is one for the production of a foamed polystyrene article, such as a block, which comprises preparing a prefoam of foamed beads from foamable particles that consist essentially of polystyrene, a volatile hydrocarbon blowing agent, and from 0.1 to 10% of a wax by weight of the polystyrene, and treating the foamed beads in a mould with steam to produce the required article.

Also part of the invention is a process for the production of the foamable polystyrene particles, in which before or after polymerisation of the styrene from 0.1 to 10% by weight of a wax is incorporated.

The volatile hydrocarbon blowing agent that is one of the essential constituents of the foamable polystyrene particles is preferably a volatile liquid blowing agent, for instance pentane or some similar volatile hydrocarbon. Usually up to about 10% of the blowing agent by weight of the polystyrene is present, for instance from 3 to 10%.

The other essential constituent is the wax, and this is preferably one having a melting point less than the softening point of the polystyrene, for example a melting point between 50°C. and 85°C., such as about 70°C. A wide range of waxes can be used, including for example beeswax, paraffin wax, ozokerite, carnauba wax or a microcrystalline wax, and excellent results have been obtained using a polyethylene wax.

Apart from the volatile hydrocarbon blowing agent and the wax the foamable polystyrene particles contain essentially no other constituent. However, in the instance for example of polystyrene particles produced by suspension polymerisation there may also be present traces of the suspending agents employed in the process of produc-

tion. In general the particles can be of any shape and prepared by any process.

The amount of wax used often does not exceed 7% by weight of the polystyrene. In general an amount between 0.5% by weight and 5%, and preferably from 1% to 2% by weight of the polystyrene gives good results.

The wax can be incorporated in any convenient way. For example particles of the foamable polystyrene can be coated by "steeping" them in a suitable molten wax, if necessary under pressure so as to minimise escape of the blowing agent, but a preferred method is to coagulate an aqueous dispersion of a wax in the presence of the foamable particles. The coagulation is preferably carried out at a temperature above the melting point of the wax, again if necessary under pressure. Another method is to arrange for a wax to be present during at least the later stages of a process of suspension polymerisation in which the polystyrene is formed, so that the wax becomes incorporated in the polystyrene particles; probably wax incorporated in this way migrates to the surface of each particle and there forms a coating. In such a process the volatile blowing agent can be added before, during or after the polymerisation of the styrene.

The foaming and moulding operations can follow ordinary practice; thus the foamable particles can for example be heated by steam, hot water or hot air, or under the influence of an infra-red heater to produce foamed beads, and these are preferably conditioned by exposing them to the atmosphere for a day or two before they are used in the moulding operation. The mould is fully or partially filled with foamed beads and closed, and then steam is injected through inlets in the mould walls. When foaming is complete, the steam supply is shut off and the article is allowed to cool in the mould before the mould is opened. The article, such as a block, is cooled to such an extent that it does not "bulge" on opening the mould.

The cooling time is substantially less than the cooling time necessary when ordinary polystyrene particles containing blowing agent only are employed. In any particular instance the cooling time depends to a certain extent on the size of the article being produced, but in many cases it has been found that the cooling time is between 30% and 80% of the "normal" cooling time. From 40% to 70%, for example 50% or 60% of the "normal" cooling time is often sufficient. Sometimes a cooling time that is only 25% of the "normal" cooling time is adequate.

The invention is illustrated by the following Example.

#### EXAMPLE

The Example describes a foamable polystyrene of the invention and the production of a foamed polystyrene article, and

demonstrates the improvement in cooling time which is obtained.

1 Pound of foamable polystyrene particles (made by suspension polymerisation) containing a pentane blowing agent were first coated with 1% of wax by weight of the polystyrene as follows. A slurry of the particles in water was prepared and heated in a closed vessel up to 85°C. with stirring. An aqueous emulsion of a polyethylene wax of melting point about 70°C. containing the wax was added and the wax emulsion was coagulated by acidification with sulphuric acid. The vessel was allowed to cool and was then opened.

A second lot of particles was coated in this way using sufficient of the wax emulsion to coat the particles with 2% by weight of wax on the polystyrene. Each lot of particles, and a portion of similar particles containing no wax as a control, was foamed in a steam atmosphere for 4 minutes, allowed to dry on an open tray for one day, and moulded into a 1 foot cube block by steam injected through a number of holes in the walls of the mould, to give a pressure of about 14 pounds per square inch for 1 minute. The block was allowed to cool, and removed from the mould when the mould could be opened without causing the block to "bulge". A number of moulding experiments were carried out using each lot of foamable polystyrene in order to determine for each the minimum cooling time. It was found that for each lot of wax-coated foamable polystyrene the minimum cooling time was 22 minutes, whereas for the control the minimum cooling time was 37 minutes.

It was therefore apparent that a considerable improvement in cooling time had been achieved with the foamable polystyrene of the invention.

#### WHAT WE CLAIM IS:—

1. Foamable polystyrene particles that consist essentially of polystyrene, a volatile hydrocarbon blowing agent, and from 0.1 to 10% of a wax by weight of the polystyrene.

2. Foamable polystyrene particles according to Claim 1, in which the blowing agent is pentane.

3. Foamable polystyrene particles according to either of Claims 1 and 2, in which the blowing agent is present in an amount corresponding to from 3 to 10% by weight of the polystyrene.

4. Foamable polystyrene particles according to any of Claims 1 to 3, in which the wax has a melting point less than the softening point of the polystyrene.

5. Foamable polystyrene particles according to Claim 4, in which the wax has a melting point between 50°C. and 85°C.

6. Foamable polystyrene particles according to any of the preceding claims, in which the wax is a polyethylene wax.

7. Foamable polystyrene particles according to any of Claims 1 to 6, in which the amount of wax is between 0.5% and 5% by weight of the polystyrene.
- 5 8. Foamable polystyrene particles according to Claim 1 substantially as described in the Example.
- 10 9. A process for the production of foamable polystyrene particles according to any of Claims 1 to 8, in which before or after polymerisation of the styrene from 0.1 to 10% of a wax by weight of polystyrene is incorporated.
- 15 10. A process according to Claim 9, in which the wax is incorporated by coagulating an aqueous dispersion of the wax in the presence of the foamable particles.
- 20 11. A process according to Claim 10, in which the coagulation is carried out at a temperature above the melting point of the wax.
- 25 12. A process according to Claim 9, in which the wax is incorporated by arranging for the wax to be present during at least the later stages of a process of suspension polymerisation in which the polystyrene is formed.
13. A process according to Claim 9 substantially as described in the Example.
14. Foamable polystyrene particles that have been produced by a process according to any of Claims 9 to 13.
15. A process for the production of a foamed polystyrene article, which comprises preparing a prefoam of foamed beads from foamable particles according to any of Claims 1 to 8, and treating the foamed beads in a mould with steam to produce the required article.
16. A process according to Claim 15, in which the article is allowed to cool in the mould for a time that is between 30% and 80% of the cooling time necessary when polystyrene particles containing blowing agent only are employed.
17. A process according to Claim 15 substantially as described in the Example.
18. A foamed polystyrene article that has been produced by a process according to any of Claims 15 to 17.

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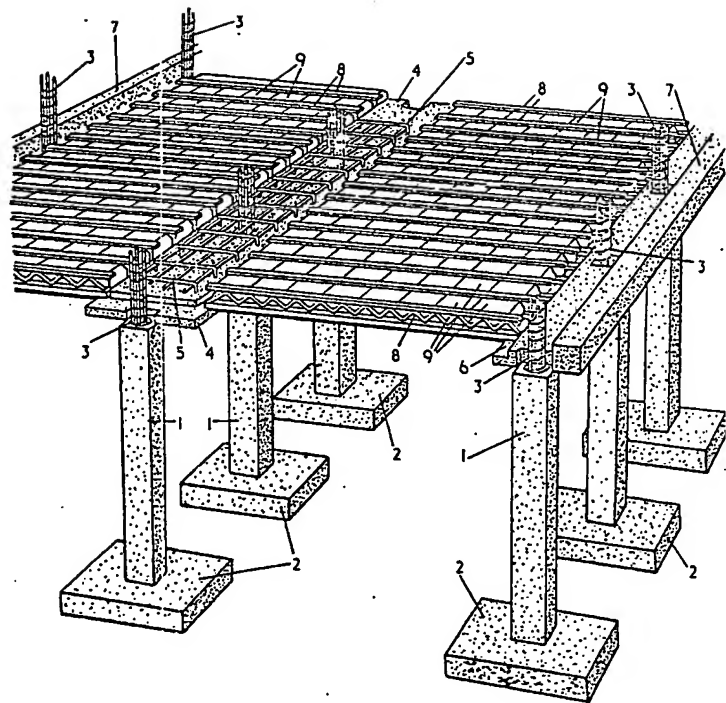


FIG. 1.

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the Original on a reduced scale*  
Sheets 1 & 2

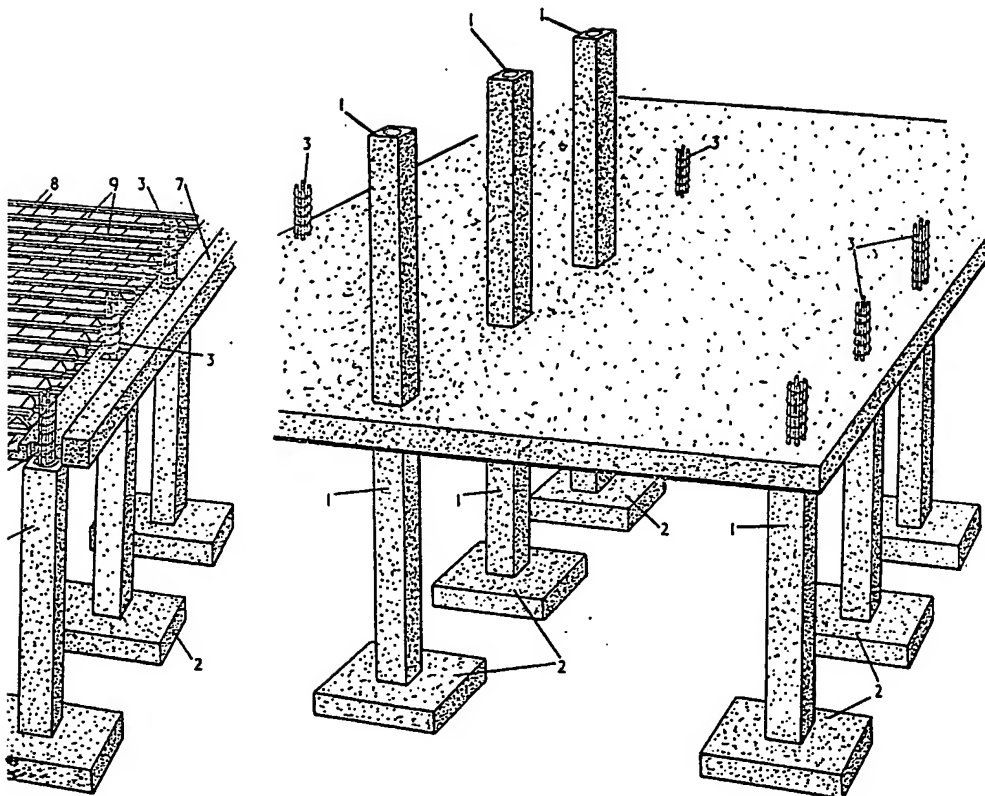


FIG. 2.

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